

## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION CONCERNING  
SUBMISSION OR TRANSMITTAL  
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DANEMARK

X

Date of mailing (day/month/year) 08 November 2000 (08.11.00)	
Applicant's or agent's file reference 72646 Si/Ve	<b>IMPORTANT NOTIFICATION</b>
International application No. PCT/DK00/00558	International filing date (day/month/year) 05 October 2000 (05.10.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 07 October 1999 (07.10.99)
Applicant VESTAS WIND SYSTEM A/S et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An **asterisk(\*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
07 Octo 1999 (07.10.99)	PA 1999 01436	DK	24 Octo 2000 (24.10.00)

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Authorized officer

Catherine Massetti

Facsimile No. (41-22) 740.14.35

Telephone No. (41-22) 338.83.38

# PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

## NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DANEMARK

Sagstype	J.nr.	Inc.
197	72646	Si.
20 APR. 2001		
AS 400	Til hvem	
	Ve	

Date of mailing (day/month/year) 12 April 2001 (12.04.01)		
Applicant's or agent's file reference 72646 Si/Ve		
<b>IMPORTANT NOTICE</b>		
International application No. PCT/DK00/00558	International filing date (day/month/year) 05 October 2000 (05.10.00)	Priority date (day/month/year) 07 October 1999 (07.10.99)
Applicant VESTAS WIND SYSTEM A/S et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:  
AU, KP, KR, US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

AE, AG, AL, AM, AP, AT, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EA, EE, EP, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OA, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU,  
The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 12 April 2001 (12.04.01) under No. WO 01/25628

### REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

### REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

## PATENT COOPERATION TREATY

X

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

To:

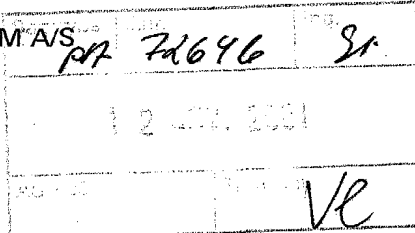
CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DANEMARK

Date of mailing (day/month/year) 07 November 2001 (07.11.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 72646 Si/Ve	
International application No. PCT/DK00/00558	International filing date (day/month/year) 05 October 2000 (05.10.00)

## 1. The following indications appeared on record concerning:

☒ the applicant
 ☐ the inventor
 ☐ the agent
 ☐ the common representative

## Name and Address

 VESTAS WIND SYSTEM A/S  
 5, Smed Sørensensvej  
 DK-6950 Ringkøbing  
 Denmark


## State of Nationality

DK

## State of Residence

DK

## Telephone No.

## Facsimile No.

## Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person
 ☒ the name
 ☐ the address
 ☐ the nationality
 ☐ the residence

## Name and Address

 VESTAS WIND SYSTEMS A/S  
 5, Smed Sørensensvej  
 DK-6950 Ringkøbing  
 Denmark

## State of Nationality

DK

## State of Residence

DK

## Telephone No.

## Facsimile No.

## Teleprinter No.

## 3. Further observations, if necessary:

The name of the applicant has been corrected

## 4. A copy of this notification has been sent to:

☒ the receiving Office
 ☐ the designated Offices concerned  
☐ the International Searching Authority
 ☒ the elected Offices concerned  
☒ the International Preliminary Examining Authority
 ☐ other:

 The International Bureau of WIPO  
 34, chemin des Colombettes  
 1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Catherine MASSETTI

Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

To:

CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DANEMARK

<b>Date of mailing</b> (day/month/year) 22 March 2002 (22.03.02)	<b>IMPORTANT NOTIFICATION</b>
<b>Applicant's or agent's file reference</b> 72646 Si/Ve	
<b>International application No.</b> PCT/DK00/00558	
	<b>International filing date</b> (day/month/year) 05 October 2000 (05.10.00)

## 1. The following indications appeared on record concerning:

☒ the applicant
     
 ☒ the inventor
     
 ☐ the agent
     
 ☐ the common representative

<b>Name and Address</b> FEDDERSEN, Lorenz 63, Brogårdsvenget DK-6950 Ringkøbing Denmark	<b>State of Nationality</b> DK	<b>State of Residence</b> DK
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person
     
 ☐ the name
     
 ☒ the address
     
 ☐ the nationality
     
 ☐ the residence

<b>Name and Address</b> FEDDERSEN, Lorenz Prof. Mensing Strasse 11 24937 Flensburg Germany	<b>State of Nationality</b> DK	<b>State of Residence</b> DE
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

<b>The International Bureau of WIPO</b> 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	<b>Authorized officer</b> Marie-José DEVILLARD Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DANEMARK

<b>Date of mailing</b> (day/month/year) 07 November 2001 (07.11.01)	<b>IMPORTANT NOTIFICATION</b>
<b>Applicant's or agent's file reference</b> 72646 Si/Ve	
<b>International application No.</b> PCT/DK00/00558	<b>International filing date</b> (day/month/year) 05 October 2000 (05.10.00)

## 1. The following indications appeared on record concerning:

☒ the applicant
                    
 ☐ the inventor
                    
 ☐ the agent
                    
 ☐ the common representative

<b>Name and Address</b> VESTAS WIND SYSTEM A/S 5, Smed Sørensenvej DK-6950 Ringkøbing Denmark	<b>State of Nationality</b> DK	<b>State of Residence</b> DK
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person
                    
 ☒ the name
                    
 ☐ the address
                    
 ☐ the nationality
                    
 ☐ the residence

<b>Name and Address</b> VESTAS WIND SYSTEMS A/S 5, Smed Sørensenvej DK-6950 Ringkøbing Denmark	<b>State of Nationality</b> DK	<b>State of Residence</b> DK
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	

## 3. Further observations, if necessary:

**The name of the applicant has been corrected**

## 4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

<b>The International Bureau of WIPO</b> 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	<b>Authorized officer</b> Catherine MASSETTI Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
 US Department of Commerce  
 United States Patent and Trademark  
 Office, PCT  
 2011 South Clark Place Room  
 CP2/5C24  
 Arlington, VA 22202  
 ETATS-UNIS D'AMERIQUE  
 in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 28 June 2001 (28.06.01)	
<b>International application No.</b> PCT/DK00/00558	<b>Applicant's or agent's file reference</b> 72646 Si/Ve
<b>International filing date</b> (day/month/year) 05 October 2000 (05.10.00)	<b>Priority date</b> (day/month/year) 07 October 1999 (07.10.99)
<b>Applicant</b> FEDDERSEN, Lorenz	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

02 May 2001 (02.05.01)



in a notice effecting later election filed with the International Bureau on:

2. The election



was



was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<b>The International Bureau of WIPO</b> 34, chemin des Colombettes 1211 Geneva 20, Switzerland	<b>Authorized officer</b> Nestor Santesso
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

INFORMATION CONCERNING ELECTED  
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

To:

CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DANEMARK

Date of mailing (day/month/year) 28 June 2001 (28.06.01)		IMPORTANT INFORMATION	
Applicant's or agent's file reference 72646 Si/Ve			
International application No. PCT/DK00/00558	International filing date (day/month/year) 05 October 2000 (05.10.00)	Priority date (day/month/year) 07 October 1999 (07.10.99)	
Applicant VESTAS WIND SYSTEM A/S et al			

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

✓ EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE  
National : AU, BG, CA, CN, CZ, DE, IL, JP, KP, KR, MN, NO, NZ, PL, RO, RU, SE, SK, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

AP : GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW  
EA : AM, AZ, BY, KG, KZ, MD, RU, TJ, TM  
OA : BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG  
National : AE, AG, AL, AM, AT, AZ, BA, BB, BR, BY, BZ, CH, CR, CU, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IN, IS, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MW, MX, MZ, PT, SD, SG, SI, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW

3. The applicant is reminded that he must enter the "national phase" before the expiration of 30 months from the priority date before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed until 31 months from the priority date for all States designated for the purposes of obtaining a European patent.

Sagstype	L.nr.	Indg.
RM	72646	Si
- 6 JULI 2001		
AS 400	Til hvorn	
	MSH	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No. (41-22) 740.14.35	Authorized officer:  Nestor Santesso  Telephone No. (41-22) 338.83.38
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REC'D 20 DEC 2001

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IPO

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference 72646 Si/Ve	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/DK00/00558	International filing date (day/month/year) 05/10/2000	Priority date (day/month/year) 07/10/1999
International Patent Classification (IPC) or national classification and IPC F03D7/00		
Applicant VESTAS WIND SYSTEM A/S et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  02/05/2001	Date of completion of this report  18.12.2001
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  Descoubes, P  Telephone No. +49 89 2399 7066  



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/DK00/00558

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, pages:**

3-6	as originally filed			
1,2	as received on	04/10/2001	with letter of	02/10/2001

**Claims, No.:**

1-9	as received on	04/10/2001	with letter of	02/10/2001
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**Drawings, sheets:**

1/5-5/5	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/DK00/00558

- ☐ the description,      pages:  
☐ the claims,      Nos.:  
☐ the drawings,      sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims 1-9
	No: Claims
Inventive step (IS)	Yes: Claims 1-9
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-9
	No: Claims

2. Citations and explanations  
**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/DK00/00558

1.0 Reference is made to the following documents:

- D1: WO 99 07996 A (ZOND ENERGY SYSTEMS INC) 18 February 1999 (1999-02-18)
- D2: WO 92 14298 A (US WINDPOWER) 20 August 1992 (1992-08-20)
- D3: EP-A-0 150 884 (TEMA SPA) 7 August 1985 (1985-08-07)
- D4: US-A-4 906 060 (CLAUDE DAVID L) 6 March 1990 (1990-03-06)
- D5: DE-A-196 20 906 (SIEMENS AG) 8 January 1998 (1998-01-08)

2.0 Independent claim 1 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined, the reasons being as follows:

- 2.1 The expression "measures being taken so as to secure against possible variations in the speed of rotation" attempts to define the subject-matter in terms of the result to be achieved, which is not permissible in the present case (see PCT-Guidelines III-4.7). The analysis is done as if this expression would not be present in the claim.
- 2.2 Furthermore, it is not clear if the word "optionally" refers to the gear only or also to the transformer, which renders claim 1 unclear with regard to what extent protection is sought for. The analysis is based on the assumption that the word "optionally" refers to the gear only.
- 2.3 The wording "whereby the AC/DC rectifier is composed of diodes" has no limiting effect. For the analysis, it is understood that the claim is worded as: "whereby the AC/DC rectifier is composed of diodes only".

3.0 Prior art document D5, which is considered to represent the most relevant state of the art, discloses a wind power plant from which the subject-matter of independent claim 1 differs in that

- a magnetic field controller is connected to the generator and is adapted to vary the magnetic field in the synchronous generator in response to a speed of rotation-depending output parameter of the generator in such a manner that possible variations in the speed of rotation are compensated for.
- the AC/DC rectifier is composed of diodes only.

The objective problem to be solved may therefore be seen as to provide a

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/DK00/00558

variable speed wind power plant for the production of DC power in which the AC/DC rectifier is of simple construction.

The solution is achieved by the characterizing part of independent claim 1.

Document D5 discloses a wind power plant for the production of DC power with a speed regulation and does not disclose a magnetic field controller, nor an AC/DC rectifier made of diodes only.

Document D1 and D2 only disclose active AC/DC rectifiers, while document D3 and D4 are directed to the control of the output frequency and do not disclose a passive AC/DC rectifier.

None of the documents give an indication that would prompt the skilled person aware of document D5 to solve the problem as stated in claim 1.

Thus, the subject matter of claim 1 is considered to be new and to involve an inventive step in the sense of Articles 33(2) and 33(3) PCT.

- 4.0 Since they all are dependent on claim 1, the subject matter of the dependent claims 2 to 9 is also considered to be new and to involve an inventive step in the sense of Article 33(2) and Article 33(3) PCT.
- 5.0 The industrial applicability of the invention is self-evident.
- 6.0 Furthermore the following should be noted:
- 6.1 The expressions "relatively low inductance" and "relatively high speed of rotation" used in claims 6 and 7 have no well-recognised meaning and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).
- 6.2 According to the requirements of Rule 11.13(m) PCT the same feature shall be denoted by the same reference sign throughout the application. This requirement is not met in view of the use of:
- reference sign 7 in the description page 5 line 6
  - references IG1 and IG2 in claim 3 (See description page 5 line 27).

Title: Wind power plantTechnical Field :

The invention relates to a wind power plant where the driving shaft communicates with a synchronous generator optionally through a gear, and where a transformer  
5 with n output windings communicates with an HVDC-transmission cable through an AC/DC-rectifier, measures being taken so as to secure against possible variations in the speed of rotation.

The use of a DC transmission cable implies that it is not necessary to take into account the capacitive load generated by the cable. In addition, it is possible to make  
10 the HVDC transmission cables longer than the AC transmission cables. These AC transmission cables must not exceed a so-called "critical length".

Background Art

WO97/45908 discloses a wind power park where each wind turbine is equipped with a synchronous generator. The output power of the synchronous generator is rectified  
15 by means of an AC/DC rectifier and transmitted through a DC transmission cable to a DC/AC inverter and a transformer so as to be transferred to the regional supply network. The AC/DC rectifier comprises controlled rectifiers, which are able to compensate for possible variations in the speed of rotation through a suitable control by means of particular control circuits. However, such control circuits are rather  
20 complicated.

WO 92/14298 and WO 99/007996 disclose a variable speed wind turbine comprising active power converters for providing AC power. These power converters include active controlled rectifiers and require expensive controller circuits.

Brief Description of the Invention.

The object of the invention is to provide a wind turbine plant where each wind turbine is able to tolerate sudden gusts and is of a more simple construction than hitherto known.

- 5 A wind turbine plant of the above type is according to the invention characterised by a magnetic field controller connected to the generator, said magnetic field controller being adapted to vary the magnetic field in the synchronous generator in response to a speed of rotation-dependent output parameter of said synchronous generator in such a manner that possible variations in the speed of rotation are compensated for, where-  
10 by the AC/DC rectifier is composed of diodes. As a result, passive rectifier elements suffice in the rectifier. In addition, the controllable rectifiers and the associated control circuits are avoided which should otherwise be used for compensating for possible variations in the speed of rotation.

- Moreover according to the invention the magnetic field controller may be adapted to  
15 detect the current generated by the synchronous generator, a negative feedback being established by means of the magnetic field controller for regulating the current through the rotor winding.

- In addition, the magnetic field controller may according to the invention be adapted to detect the voltage generated by the synchronous generator, a negative feedback  
20 being established by means of said magnetic field controller.

Moreover, the magnetic field controller may according to the invention be adapted to detect the power generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.

Claims

1. A wind power plant where the driving shaft communicates with a synchronous generator (3) optionally through a gear (2) and with a transformer with n output windings, said transformer communicating through an AC/DC rectifier with an HVDC transmission cable (9), measures being taken so as to secure against possible variations in the speed of rotation, c h a r a c t e r i s e d by a magnetic field controller (4) connected to the generator (3), said magnetic field controller (4) being adapted to vary the magnetic field in the synchronous generator (3) in response to a speed of rotation-depending output parameter of said generator (3) in such a manner that possible variations in the speed of rotation are compensated for, whereby the AC/DC rectifier is composed of diodes.
2. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the currents (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
3. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the voltages (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
4. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the power generated by the generator (3), a negative feedback being established for regulating the current through the rotor winding (3a) in response to the detected power.
5. A wind power plant as claimed in claim 4, c h a r a c t e r i s e d in that the negative feedback for regulating the current through the rotor windings (3a) includes a P, I or D regulation or a combination thereof.

6. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the rotor windings are dimensioned with a relatively low  
inductance.

7. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
5 a c t e r i s e d in that the rotor is adapted to rotate at a relatively high speed of  
rotation, whereby the inductance can be further reduced.

8. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the synchronous generator (3) is multipolar.

9. A wind power plant as claimed in one or more of the preceding claims, where the  
10 wind turbine comprises a transformer with n output windings coupled in series with  
n rectifiers so as to obtain an HVDC.



*Chas. Hude*

Patents • Trade Marks • Design

European Patent Office  
International preliminary  
examining authority  
D-80298 Munich

PCT Chapter II  
MU DG 2

Dear Sirs

International patent application No PCT/DK00/00558  
Applicant: Vestas Wind System A/S, et al  
International patent classification: F 03 D 7/00  
My ref: 72646 Si/Ve

Time limit: 13 October 2001

In response to the WRITTEN OPINION dated 13 August 2001, I hereby file a proposal for a new set of claims together with a new introduction to the specification in duplicate.

I further enclose a draft showing the amendments in handwriting.

The new claims 1 to 9 correspond substantially to the old claims 1 to 9.

WO 92/14298 (D2) discloses a variable speed wind turbine comprising active power converters for providing AC power. These power converters include active controlled rectifiers and require expensive controller circuits. The wind power system according to the invention is only adapted to provide DC power, and this has been obtained by means of converters consisting of diodes. Such diodes do not require expensive controller circuits. The wind power system according to the invention is therefore different from the wind power system according to D2. D2 is therefore not anticipatory.

WO 99/07996 (D1) discloses a variable speed wind turbine system. The wind turbine system comprises a pitch controller and a torque controller, said controllers being adapted to operate

PATENTS

Tage Nørgaard °°  
Ulrik Nørgaard °°  
Ole Thierry-Jensen °°  
Peter Kim Jensen °°  
Ulla C. Klinge °°  
Jørgen Siiger °°  
Henrik Zeuthen-Aagaard °°  
Erik Lichtenberg °°  
Bent Christensen °°  
Henrik Dylmer °°  
Peter Englev °°  
Ebbe Johansen  
Michael Henriksen  
Ulrik von Freiesleben  
Hans Henrik Børstrup  
Hans P. Mathiesen °° consultant  
Susanne Nord secretariat  
Kirsten M. Jensen annuities

10/089291

TRADE MARKS  
AND DESIGNS

Kaj L. Henriksen °°  
Henrik Jespersen °°  
Claus Hyllinge °°  
Birgitte Waagepetersen °°  
Christian Kragelund °°  
Peter Larsen °°  
Kristiane B. Vandborg  
Inge Petersen renewals  
Sonja Nielsen assignments

ACCOUNTING/DP  
Steffen Hussing

° Member of The Association  
of Danish Patent Agents  
° European Patent Attorney  
° European Trade Mark  
Attorney

1015 Rec'd PCT/PTO 27 MAR 2002

2 October 2001

X

independently. Inverters (624, 630) (including active controlled rectifiers) require controller circuits. Such controller circuits have been omitted in the wind turbine system according to the invention. **D1** is therefore not anticipatory either.

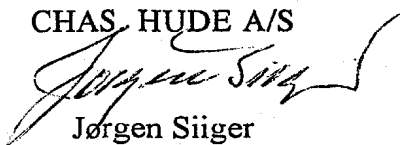
**US 4.906.060 (D4)** discloses a wind turbine system comprising an apparatus for controlling the output frequency of an alternator by maintaining a relatively constant speed of rotation by increasing or decreasing the stator magnetic field. The magnetic field is controlled by means of a very complicated control circuit in the shape of a logic circuit (42) controlling an address decoder/driver (54), and **D4** is therefore not anticipatory.

**EP 0150884 (D3)** discloses a wind turbine generator for providing a fixed frequency. In a first embodiment, the frequency is detected by means of a tachometer controlling the internal magnetic field in response thereto. In a second embodiment, the generator acts as a DC generator for providing DC, which by means of a converter is converted into AC of the frequency of the mains. None of these embodiments illustrate a converter in the shape of diodes and is therefore not anticipatory.

**DE-OS 196 20 906 (D5)** does not illustrate how it is possible to adapt a magnetic field controller to vary the magnetic fields in a synchronous generator in response to the speed of rotation and is therefore not anticipatory either.

Yours faithfully

CHAS. HUDE A/S



Jørgen Siiger

Representative of the applicant

Encs: Proposal for a new set of claims in duplicate

Proposal for a new introduction to the specification in duplicate

Draft

EPO Form 1038

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ EP

PCT

DEMAND

CHAPTER II

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only		
Identification of IPEA		Date of receipt of DEMAND
<b>Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION</b>		Applicant's or agent's file reference 72646 Si/ve
International application No. PCT/DK00/00558	International filing date (day/month/year) 5 October 2000 (05.10.2000)	(Earliest) Priority date (day/month/year) 7 October 1999 (07.10.1999)
Title of invention Wind power plant		
<b>Box No. II APPLICANT(S)</b>		
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)  Vestas Wind System A/S 5, Smed Sørensenvej DK-6950 Ringkøbing DENMARK		Telephone No.: + 45 96 75 25 75
		Facsimile No.: + 45 96 75 24 36
		Teleprinter No.:
State (that is, country) of nationality: Denmark		State (that is, country) of residence: Denmark
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)  FEDDERSEN, Lorenz 63, Brogårdsvænget DK-6950 Ringkøbing DENMARK		
State (that is, country) of nationality: Denmark		State (that is, country) of residence: Denmark
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)  		
State (that is, country) of nationality:		State (that is, country) of residence:
<input type="checkbox"/> Further applicants are indicated on a continuation sheet.		

**Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE**The following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.Name and address: *(Family name followed by given name; for a legal entity, full official designation.  
The address must include postal code and name of country.)*CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DENMARK

Telephone No.:

+ 45 33 15 45 14

Facsimile No.:

+ 45 33 15 45 35

Teleprinter No.:

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:\***

1. The applicant wishes the international preliminary examination to start on the basis of:

☒ the international application as originally filed

the description

☒ as originally filed☐ as amended under Article 34

the claims

☒ as originally filed☐ as amended under Article 19 (together with any accompanying statement)☐ as amended under Article 34

the drawings

☒ as originally filed☐ as amended under Article 342. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

\* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

**Language for the purposes of international preliminary examination:** English☒ which is the language in which the international application was filed.☐ which is the language of a translation furnished for the purposes of international search.☐ which is the language of publication of the international application.☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.**Box No. V ELECTION OF STATES**

The applicant hereby elects all eligible States (that is, all States which have been designated and which are bound by Chapter II of the PCT)

excluding the following States which the applicant wishes not to elect:

**Box No. VI CHECK LIST**

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- |  |   |        |
|--|---|--------|
| 1. translation of international application                              | : | sheets |
| 2. amendments under Article 34   | : | sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4. copy (or, where required, translation) of statement under Article 19  | : | sheets |
| 5. letter  | : | sheets |
| 6. other (specify) Copy of Int. Search Report : 4                        | : | sheets |

For International Preliminary Examining Authority use only

received not received

<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

The demand is also accompanied by the item(s) marked below:

- |  |   |
|--|---|
| 1. <input checked="" type="checkbox"/> fee calculation sheet                             | 4. <input type="checkbox"/> statement explaining lack of signature                                  |
| 2. <input type="checkbox"/> separate signed power of attorney                            | 5. <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6. <input checked="" type="checkbox"/> other (specify): Copy of Int. Search Report                  |

**Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE**

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

  
Jørgen Sliger  
Representative of the applicant

**For International Preliminary Examining Authority use only**

1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply. ☐ The applicant has been informed accordingly.

4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.

5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

**For International Bureau use only**

Demand received from IPEA on:

# PATENT COOPERATION TREATY

X

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

## PCT

To:  
CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
1780 Copenhagen V  
DANEMARK

Sagstype PA	J.nr. 72646	Ing. Si
<b>27 DEC. 2001</b>		
AS 400	Til hvem	VE

NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT  
(PCT Rule 71.1)

Date of mailing (day/month/year)	18.12.2001
-------------------------------------	------------

Applicant's or agent's file reference  
72646 Si/ve

### IMPORTANT NOTIFICATION

International application No.  
PCT/DK00/00558

International filing date (day/month/year)  
05/10/2000

Priority date (day/month/year)  
07/10/1999

Applicant  
VESTAS WIND SYSTEM A/S et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

#### 4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/

 European Patent Office  
D-80298 Munich  
Tel. +49 89 2399 - 0 Tx: 523656 epmu d  
Fax: +49 89 2399 - 4465

Authorized officer

Goenechea Olmos, A

Tel. +49 89 2399-2664



# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT


(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>72646 Si/Ve</b>	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. <b>PCT/DK00/00558</b>	International filing date ( <i>day/month/year</i> ) <b>05/10/2000</b>	Priority date ( <i>day/month/year</i> ) <b>07/10/1999</b>
International Patent Classification (IPC) or national classification and IPC <b>F03D7/00</b>		
Applicant <b>VESTAS WIND SYSTEM A/S et al.</b>		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
 These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  <b>02/05/2001</b>	Date of completion of this report  <b>18.12.2001</b>
Name and mailing address of the international preliminary examining authority:   <b>European Patent Office</b> <b>D-80298 Munich</b> <b>Tel. +49 89 2399 - 0 Tx: 523656 epmu d</b> <b>Fax: +49 89 2399 - 4465</b>	Authorized officer  <b>Descoubes, P</b>  Telephone No. <b>+49 89 2399 7066</b>



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/DK00/00558

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, pages:

3-6	as originally filed			
1,2	as received on	04/10/2001	with letter of	02/10/2001

### Claims, No.:

1-9	as received on	04/10/2001	with letter of	02/10/2001
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### Drawings, sheets:

1/5-5/5	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/DK00/00558

- ☐ the description,      pages:  
☐ the claims,      Nos.:  
☐ the drawings,      sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Yes:	Claims	1-9
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-9
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-9
	No:	Claims	

2. Citations and explanations  
**see separate sheet**

## VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

## VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

---

International application No. PCT/DK00/00558

1.0 Reference is made to the following documents:

- D1: WO 99 07996 A (ZOND ENERGY SYSTEMS INC) 18 February 1999 (1999-02-18)
- D2: WO 92 14298 A (US WINDPOWER) 20 August 1992 (1992-08-20)
- D3: EP-A-0 150 884 (TEMA SPA) 7 August 1985 (1985-08-07)
- D4: US-A-4 906 060 (CLAUDE DAVID L) 6 March 1990 (1990-03-06)
- D5: DE-A-196 20 906 (SIEMENS AG) 8 January 1998 (1998-01-08)

2.0 Independent claim 1 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined, the reasons being as follows:

2.1 The expression "measures being taken so as to secure against possible variations in the speed of rotation" attempts to define the subject-matter in terms of the result to be achieved, which is not permissible in the present case (see PCT-Guidelines III-4.7). The analysis is done as if this expression would not be present in the claim.

2.2 Furthermore, it is not clear if the word "optionally" refers to the gear only or also to the transformer, which renders claim 1 unclear with regard to what extent protection is sought for. The analysis is based on the assumption that the word "optionally" refers to the gear only.

2.3 The wording "whereby the AC/DC rectifier is composed of diodes" has no limiting effect. For the analysis, it is understood that the claim is worded as: "whereby the AC/DC rectifier is composed of diodes only".

3.0 Prior art document D5, which is considered to represent the most relevant state of the art, discloses a wind power plant from which the subject-matter of independent claim 1 differs in that

- a magnetic field controller is connected to the generator and is adapted to vary the magnetic field in the synchronous generator in response to a speed of rotation-depending output parameter of the generator in such a manner that possible variations in the speed of rotation are compensated for.
- the AC/DC rectifier is composed of diodes only.

The objective problem to be solved may therefore be seen as to provide a

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/DK00/00558

variable speed wind power plant for the production of DC power in which the AC/DC rectifier is of simple construction.

The solution is achieved by the characterizing part of independent claim 1.

Document D5 discloses a wind power plant for the production of DC power with a speed regulation and does not disclose a magnetic field controller, nor an AC/DC rectifier made of diodes only.

Document D1 and D2 only disclose active AC/DC rectifiers, while document D3 and D4 are directed to the control of the output frequency and do not disclose a passive AC/DC rectifier.

None of the documents give an indication that would prompt the skilled person aware of document D5 to solve the problem as stated in claim 1.

Thus, the subject matter of claim 1 is considered to be new and to involve an inventive step in the sense of Articles 33(2) and 33(3) PCT.

4.0 Since they all are dependent on claim 1, the subject matter of the dependent claims 2 to 9 is also considered to be new and to involve an inventive step in the sense of Article 33(2) and Article 33(3) PCT.

5.0 The industrial applicability of the invention is self-evident.

6.0 Furthermore the following should be noted:

6.1 The expressions "relatively low inductance" and "relatively high speed of rotation" used in claims 6 and 7 have no well-recognised meaning and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).

6.2 According to the requirements of Rule 11.13(m) PCT the same feature shall be denoted by the same reference sign throughout the application. This requirement is not met in view of the use of:

- reference sign 7 in the description page 5 line 6
- references IG1 and IG2 in claim 3 (See description page 5 line 27).

Title: Wind power plant

Technical Field :

The invention relates to a wind power plant where the driving shaft communicates with a synchronous generator optionally through a gear, and where a transformer  
5 with n output windings communicates with an HVDC-transmission cable through an AC/DC-rectifier, measures being taken so as to secure against possible variations in the speed of rotation.

The use of a DC transmission cable implies that it is not necessary to take into account the capacitive load generated by the cable. In addition, it is possible to make  
10 the HVDC transmission cables longer than the AC transmission cables. These AC transmission cables must not exceed a so-called "critical length".

Background Art

WO97/45908 discloses a wind power park where each wind turbine is equipped with a synchronous generator. The output power of the synchronous generator is rectified  
15 by means of an AC/DC rectifier and transmitted through a DC transmission cable to a DC/AC inverter and a transformer so as to be transferred to the regional supply network. The AC/DC rectifier comprises controlled rectifiers, which are able to compensate for possible variations in the speed of rotation through a suitable control by means of particular control circuits. However, such control circuits are rather  
20 complicated.

WO 92/14298 and WO 99/007996 disclose a variable speed wind turbine comprising active power converters for providing AC power. These power converters include active controlled rectifiers and require expensive controller circuits.

Brief Description of the Invention.

The object of the invention is to provide a wind turbine plant where each wind turbine is able to tolerate sudden gusts and is of a more simple construction than hitherto known.

- 5 A wind turbine plant of the above type is according to the invention characterised by a magnetic field controller connected to the generator, said magnetic field controller being adapted to vary the magnetic field in the synchronous generator in response to a speed of rotation-depending output parameter of said synchronous generator in such a manner that possible variations in the speed of rotation are compensated for, where-  
10 by the AC/DC rectifier is composed of diodes. As a result, passive rectifier elements suffice in the rectifier. In addition, the controllable rectifiers and the associated control circuits are avoided which should otherwise be used for compensating for possible variations in the speed of rotation.

- Moreover according to the invention the magnetic field controller may be adapted to  
15 detect the current generated by the synchronous generator, a negative feedback being established by means of the magnetic field controller for regulating the current through the rotor winding.

- In addition, the magnetic field controller may according to the invention be adapted to detect the voltage generated by the synchronous generator, a negative feedback  
20 being established by means of said magnetic field controller.

Moreover, the magnetic field controller may according to the invention be adapted to detect the power generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.

Claims

1. A wind power plant where the driving shaft communicates with a synchronous generator (3) optionally through a gear (2) and with a transformer with n output windings, said transformer communicating through an AC/DC rectifier with an HVDC transmission cable (9), measures being taken so as to secure against possible variations in the speed of rotation, c h a r a c t e r i s e d by a magnetic field controller (4) connected to the generator (3), said magnetic field controller (4) being adapted to vary the magnetic field in the synchronous generator (3) in response to a speed of rotation-depending output parameter of said generator (3) in such a manner that possible variations in the speed of rotation are compensated for, whereby the AC/DC rectifier is composed of diodes.

2. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the currents (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).

3. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the voltages (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).

4. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the power generated by the generator (3), a negative feedback being established for regulating the current through the rotor winding (3a) in response to the detected power.

5. A wind power plant as claimed in claim 4, c h a r a c t e r i s e d in that the negative feedback for regulating the current through the rotor windings (3a) includes a P, I or D regulation or a combination thereof.

6. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the rotor windings are dimensioned with a relatively low  
inductance.
7. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
5 a c t e r i s e d in that the rotor is adapted to rotate at a relatively high speed of  
rotation, whereby the inductance can be further reduced.
8. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the synchronous generator (3) is multipolar.
9. A wind power plant as claimed in one or more of the preceding claims, where the  
10 wind turbine comprises a transformer with n output windings coupled in series with  
n rectifiers so as to obtain an HVDC.

DRAFT

Oct. 2001

Title: Wind power plantTechnical Field

The invention relates to a wind power plant where the driving shaft communicates with a synchronous generator optionally through a gear, and where a transformer, <sup>with n output windings</sup> ~~if any~~, communicates with an HVDC-transmission cable through an AC/DC-rectifier, measures being taken so as to secure against possible variations in the speed of rotation.

Background Art

The use of a DC transmission cable implies that it is not necessary to take into account the capacitive load generated by the cable. In addition, it is possible to make the HVDC transmission cables longer than the AC transmission cables. These AC transmission cables must not exceed a so-called "critical length".

Background Art

WO97/45908 discloses a wind power park where each wind turbine is equipped with a synchronous generator. The output power of the synchronous generator is rectified by means of an AC/DC rectifier and <sup>transmitted</sup> ~~carried~~ through a DC transmission cable to a DC/AC inverter and a transformer so as to be transferred to the regional supply network. Means are provided for regulating the power. This known wind power site is encumbered with the draw-back that it cannot to a sufficient extent compensate for sudden, strong gusts, and it is not equipped with an HVDC output by means of a transformer with several output windings.

In addition, the AC/DC rectifier comprises controlled rectifiers, which are able to compensate for possible variations in the speed of rotation through a suitable control by means of particular control circuits. However, such control circuits are rather complicated.

(A) Brief disclosure of WO 92/14298  
and WO 93/007956



Brief Description of the Invention.

The object of the invention is to provide a wind turbine plant where each wind turbine <sup>is able to</sup> ~~can tolerate~~ sudden gusts to a far higher extent than previously known, and where each wind turbine is of a <sup>construction</sup> ~~far~~ more simple structure than hitherto known.

- 5 A wind turbine plant of the above type is according to the invention characterised <sup>by</sup> ~~in~~ that it comprises a magnetic field controller connected to the synchronous generator, said magnetic field controller being adapted to vary the magnetic field in the synchronous generator in response to <sup>(a speed of rotation - depending)</sup> ~~an~~ output parameter of said synchronous generator in such a manner that possible variations in the speed of rotation are compensated for,
- 10 whereby <sup>the AC/DC rectifier is composed of diodes</sup> ~~a possible increase of the speed of rotation causes a reduction of the magnet-~~ ic field in the synchronous generator. As a result, passive rectifier elements suffice in the rectifier. In addition, the controllable rectifiers and the associated control circuits are avoided which should otherwise be used for compensating for possible variations in the speed of rotation.
- 15 Moreover according to the invention the magnetic field controller may be adapted to detect the current generated by the synchronous generator, a negative feedback being established by means of the magnetic field controller for regulating the current through the rotor winding.

- In addition, the magnetic field controller may according to the invention be adapted
- 20 to detect the voltage generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.

Moreover, the magnetic field controller may according to the invention be adapted to detect the power generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.

DRAFT

Oct. 2001

Claims

1. A wind power plant where the driving shaft communicates with a synchronous generator (3) optionally through a gear (2) and with a transformer (if any) with n output windings, said transformer communicating through an AC/DC rectifier with an HVDC transmission cable (9), measures being taken so as to secure against possible variations in the speed of rotation, characterised by a magnetic field controller (4) connected to the generator (3), said magnetic field controller (4) being adapted to vary the magnetic field in the synchronous generator (3) in response to a speed of rotation-dependent output parameter of said generator (3) in such a manner that possible variations in the speed of rotation are compensated for. *whereby the AC/DC rectifier is composed of diodes*
2. A wind power plant as claimed in claim 1, characterised in that the magnetic field controller (4) is adapted to detect the currents (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
3. A wind power plant as claimed in claim 1, characterised in that the magnetic field controller (4) is adapted to detect the voltages (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
4. A wind power plant as claimed in claim 1, characterised in that the magnetic field controller (4) is adapted to detect the power generated by the generator (3), a negative feedback being established for regulating the current through the rotor winding (3a) in response to the detected power.
5. A wind power plant as claimed in claim 4, characterised in that the negative feedback for regulating the current through the rotor windings (3a) includes a P, I or D regulation or a combination thereof.

Title: Wind power plant

Technical Field

The invention relates to a wind power plant where the driving shaft communicates with a synchronous generator optionally through a gear, and where a transformer, if any, communicates with an HVDC-transmission cable through an AC/DC-rectifier, measures being taken so as to secure against possible variations in the speed of rotation.

Background Art

The use of a DC transmission cable implies that it is not necessary to take into account the capacitive load generated by the cable. In addition, it is possible to make the HVDC transmission cables longer than the AC transmission cables. These AC transmission cables must not exceed a so-called "critical length".

WO97/45908 discloses a wind power park where each wind turbine is equipped with a synchronous generator. The output power of the synchronous generator is rectified by means of an AC/DC rectifier and carried through a DC transmission cable to a DC/AC inverter and a transformer so as to be transferred to the regional supply network. Means are provided for regulating the power. This known wind power site is encumbered with the draw-back that it cannot to a sufficient extent compensate for sudden, strong gusts, and it is not equipped with an HVDC output by means of a transformer with several output windings.

In addition, the AC/DC rectifier comprises controlled rectifiers, which are able to compensate for possible variations in the speed of rotation through a suitable control by means of particular control circuits. However, such control circuits are rather complicated.

### Brief Description of the Invention.

The object of the invention is to provide a wind turbine plant where each wind turbine can tolerate sudden gusts to a far higher extent than previously known, and where each wind turbine is of a far more simple structure than hitherto known.

- 5 A wind turbine plant of the above type is according to the invention characterised in that it comprises a magnetic field controller connected to the synchronous generator, said magnetic field controller being adapted to vary the magnetic field in the synchronous generator in response to an output parameter of said synchronous generator in such a manner that possible variations in the speed of rotation are compensated for,
- 10 whereby a possible increase of the speed of rotation causes a reduction of the magnetic field in the synchronous generator. As a result, passive rectifier elements suffice in the rectifier. In addition, the controllable rectifiers and the associated control circuits are avoided which should otherwise be used for compensating for possible variations in the speed of rotation.
- 15 Moreover according to the invention the magnetic field controller may be adapted to detect the current generated by the synchronous generator, a negative feedback being established by means of the magnetic field controller for regulating the current through the rotor winding.

- In addition, the magnetic field controller may according to the invention be adapted
- 20 to detect the voltage generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.

Moreover, the magnetic field controller may according to the invention be adapted to detect the power generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.

Claims

1. A wind power plant where the driving shaft communicates with a synchronous generator (3) optionally through a gear (2) and with a transformer, if any, with n output windings, said transformer communicating through an AC/DC rectifier with  
5 an HVDC transmission cable (9), measures being taken so as to secure against possible variations in the speed of rotation, c h a r a c t e r i s e d by a magnetic field controller (4) connected to the generator (3), said magnetic field controller (4) being adapted to vary the magnetic field in the synchronous generator (3) in response to a speed of rotation-depending output parameter of said generator (3) in such a manner  
10 that possible variations in the speed of rotation are compensated for.
2. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the currents (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
- 15 3. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the voltages (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
4. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the  
20 magnetic field controller (4) is adapted to detect the power generated by the generator (3), a negative feedback being established for regulating the current through the rotor winding (3a) in response to the detected power.
5. A wind power plant as claimed in claim 4, c h a r a c t e r i s e d in that the negative feedback for regulating the current through the rotor windings (3a) includes  
25 a P, I or D regulation or a combination thereof.

6. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the rotor windings are dimensioned with a relatively low  
inductance.
7. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
5 a c t e r i s e d in that the rotor is adapted to rotate at a relatively high speed of  
rotation, whereby the inductance can be further reduced.
8. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the synchronous generator (3) is multipolar.
9. A wind power plant as claimed in one or more of the preceding claims, where the  
10 wind turbine comprises a transformer with n output windings coupled in series with  
n rectifiers so as to obtain an HVDC.

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) 72646 Si/Ve

Box No. I TITLE OF INVENTION

Wind power plant

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

Vestas Wind System A/S  
5, Smed Sørensensvej  
DK-6950 Ringkøbing  
DENMARK

☐ This person is also inventor.

Telephone No.

+ 45 96 75 25 75

Facsimile No.

+ 45 96 75 24 36

Teleprinter No.

State (that is, country) of nationality:  
Denmark

State (that is, country) of residence:  
Denmark

This person is applicant  
for the purposes of:

☐ all designated  
States

☒ all designated States except  
the United States of America

☐ the United States  
of America only

☐ the States indicated in  
the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

FEDDERSEN, Lorenz  
63, Brogårdsvænget  
DK-6950 Ringkøbing  
DENMARK

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only (If this check-box  
is marked, do not fill in below.)

State (that is, country) of nationality:  
Denmark

State (that is, country) of residence:  
Denmark

This person is applicant  
for the purposes of:

☐ all designated  
States

☐ all designated States except  
the United States of America

☒ the United States  
of America only

☐ the States indicated in  
the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf  
of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

CHAS. HUDE A/S  
33, H.C. Andersens Boulevard  
DK-1780 Copenhagen V  
DENMARK

Telephone No.

+ 45 33 15 45 14

Facsimile No.

+ 45 33 15 45 35

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☒ AP ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, MZ Mozambique, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ OA OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> AE United Arab Emirates                  | <input checked="" type="checkbox"/> LC Saint Lucia                               |
| <input checked="" type="checkbox"/> AG Antigua and Barbuda                   | <input checked="" type="checkbox"/> LK Sri Lanka                                 |
| <input checked="" type="checkbox"/> AL Albania                               | <input checked="" type="checkbox"/> LR Liberia                                   |
| <input checked="" type="checkbox"/> AM Armenia                               | <input checked="" type="checkbox"/> LS Lesotho                                   |
| <input checked="" type="checkbox"/> AT Austria (and Utility Model)           | <input checked="" type="checkbox"/> LT Lithuania                                 |
| <input checked="" type="checkbox"/> AU Australia                             | <input checked="" type="checkbox"/> LU Luxembourg                                |
| <input checked="" type="checkbox"/> AZ Azerbaijan                            | <input checked="" type="checkbox"/> LV Latvia                                    |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina                | <input checked="" type="checkbox"/> MA Morocco                                   |
| <input checked="" type="checkbox"/> BB Barbados                              | <input checked="" type="checkbox"/> MD Republic of Moldova                       |
| <input checked="" type="checkbox"/> BG Bulgaria                              | <input checked="" type="checkbox"/> MG Madagascar                                |
| <input checked="" type="checkbox"/> BR Brazil                                | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BY Belarus                               | <input checked="" type="checkbox"/> MN Mongolia                                  |
| <input checked="" type="checkbox"/> BZ Belize                                | <input checked="" type="checkbox"/> MW Malawi                                    |
| <input checked="" type="checkbox"/> CA Canada                                | <input checked="" type="checkbox"/> MX Mexico                                    |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein  | <input checked="" type="checkbox"/> MZ Mozambique                                |
| <input checked="" type="checkbox"/> CN China                                 | <input checked="" type="checkbox"/> NO Norway                                    |
| <input checked="" type="checkbox"/> CR Costa Rica                            | <input checked="" type="checkbox"/> NZ New Zealand                               |
| <input checked="" type="checkbox"/> CU Cuba                                  | <input checked="" type="checkbox"/> PL Poland                                    |
| <input checked="" type="checkbox"/> CZ Czech Republic (and Utility Model)    | <input checked="" type="checkbox"/> PT Portugal                                  |
| <input checked="" type="checkbox"/> DE Germany (and Utility Model)           | <input checked="" type="checkbox"/> RO Romania                                   |
| <input checked="" type="checkbox"/> DK Denmark (and Utility Model)           | <input checked="" type="checkbox"/> RU Russian Federation                        |
| <input checked="" type="checkbox"/> DM Dominica                              | <input checked="" type="checkbox"/> SD Sudan                                     |
| <input checked="" type="checkbox"/> DZ Algeria                               | <input checked="" type="checkbox"/> SE Sweden                                    |
| <input checked="" type="checkbox"/> EE Estonia (and Utility Model)           | <input checked="" type="checkbox"/> SG Singapore                                 |
| <input checked="" type="checkbox"/> ES Spain                                 | <input checked="" type="checkbox"/> SI Slovenia                                  |
| <input checked="" type="checkbox"/> FI Finland (and Utility Model)           | <input checked="" type="checkbox"/> SK Slovakia (and Utility Model)              |
| <input checked="" type="checkbox"/> GB United Kingdom                        | <input checked="" type="checkbox"/> SL Sierra Leone                              |
| <input checked="" type="checkbox"/> GD Grenada                               | <input checked="" type="checkbox"/> TJ Tajikistan                                |
| <input checked="" type="checkbox"/> GE Georgia                               | <input checked="" type="checkbox"/> TM Turkmenistan                              |
| <input checked="" type="checkbox"/> GH Ghana                                 | <input checked="" type="checkbox"/> TR Turkey                                    |
| <input checked="" type="checkbox"/> GM Gambia                                | <input checked="" type="checkbox"/> TT Trinidad and Tobago                       |
| <input checked="" type="checkbox"/> HR Croatia                               | <input checked="" type="checkbox"/> TZ United Republic of Tanzania               |
| <input checked="" type="checkbox"/> HU Hungary                               | <input checked="" type="checkbox"/> UA Ukraine                                   |
| <input checked="" type="checkbox"/> ID Indonesia                             | <input checked="" type="checkbox"/> UG Uganda                                    |
| <input checked="" type="checkbox"/> IL Israel                                | <input checked="" type="checkbox"/> US United States of America                  |
| <input checked="" type="checkbox"/> IN India                                 | <input checked="" type="checkbox"/> UZ Uzbekistan                                |
| <input checked="" type="checkbox"/> IS Iceland                               | <input checked="" type="checkbox"/> VN Viet Nam                                  |
| <input checked="" type="checkbox"/> JP Japan                                 | <input checked="" type="checkbox"/> YU Yugoslavia                                |
| <input checked="" type="checkbox"/> KE Kenya                                 | <input checked="" type="checkbox"/> ZA South Africa                              |
| <input checked="" type="checkbox"/> KG Kyrgyzstan                            | <input checked="" type="checkbox"/> ZW Zimbabwe                                  |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea |  |
| <input checked="" type="checkbox"/> KR Republic of Korea                     |  |
| <input checked="" type="checkbox"/> KZ Kazakhstan                            |  |

Check-box reserved for designating States which have become party to the PCT after issuance of this sheet:

**Precautionary Designation Statement:** In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)



**Box No. VI PRIORITY CLAIM** ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application:* regional Office	international application: receiving Office
item (1) 7.10.1999 7 October 1999	PA 1999 01436	Denmark		
item (2)				
item (3)				

☐ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s):

\* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

**Box No. VII INTERNATIONAL SEARCHING AUTHORITY**

**Choice of International Searching Authority (ISA)**  
(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

ISA/EP

**Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):**

Date (day/month/year)

Number

Country (or regional Office)

**Box No. VIII CHECK LIST; LANGUAGE OF FILING**

This international application contains the following number of sheets:

request : 3  
description (excluding  
sequence listing part) : 6  
claims : 2  
abstract : 1  
drawings : 5  
sequence listing part  
of description : \_\_\_\_\_

Total number of sheets : 17

This international application is accompanied by the item(s) marked below:

- ☒ fee calculation sheet
- ☐ separate signed power of attorney
- ☐ copy of general power of attorney, reference number, if any:
- ☐ statement explaining lack of signature
- ☒ priority document(s) identified in Box No. VI as item(s):
- ☐ translation of international application into (language): English
- ☐ separate indications concerning deposited microorganism or other biological material
- ☐ nucleotide and/or amino acid sequence listing in computer readable form
- ☒ other (specify):

Copy of Off Action received in PA 1999 01436

Figure of the drawings which  
should accompany the abstract:

4

Language of filing of the  
international application:

English

**Box No. IX SIGNATURE OF APPLICANT OR AGENT**

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Vestas Wind System A/S

Group leader, Msc.EE.



Anders Rebsdorf

M.sc.EE.



Lorenz Feddersen

For receiving Office use only		2. Drawings:  <input type="checkbox"/> received:  <input type="checkbox"/> not received:
1. Date of actual receipt of the purported international application:		
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
5. International Searching Authority (if two or more are competent): ISA /	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.	

Date of receipt of the record copy  
by the International Bureau:

# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>72646 Si/Ve</b>	<b>FOR FURTHER ACTION</b> <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small>	
International application No. <b>PCT/DK 00/ 00558</b>	International filing date (day/month/year) <b>05/10/2000</b>	(Earliest) Priority Date (day/month/year) <b>07/10/1999</b>
Applicant  <b>VESTAS WIND SYSTEM A/S et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.  
☒ It is also accompanied by a copy of each prior art document cited in this report.

**1. Basis of the report**

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

**4. With regard to the title,**

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established by this Authority to read as follows:

**5. With regard to the abstract,**

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

- ☒ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.

4  
☐ None of the figures.

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/DK 00/00558

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 F03D7/00 H02P 9/00 //F03D11/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F03D H02P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99 07996 A (ZOND ENERGY SYSTEMS INC) 18 February 1999 (1999-02-18) page 13, line 9 -page 14, paragraph 20 page 22, line 11 -page 24, line 24; figures 1-68	1-9
X	WO 92 14298 A (US WINDPOWER) 20 August 1992 (1992-08-20) page 3, line 1 -page 8, line 4 page 14, line 18 -page 15, line 24; figures 1-3,13	1,8,9
X	EP 0 150 884 A (TEMA SPA) 7 August 1985 (1985-08-07) page 6, line 10-12 abstract; claims 1-5	1,8
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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Date of the actual completion of the international search

22 December 2000

Date of mailing of the international search report

20. 04. 2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
 Fax: (+31-70) 340-3016

Authorized officer

Peter Göransson

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/DK 00/00558

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	WO 90 07823 A (ELIN ENERGIEVERSORGUNG) 12 July 1990 (1990-07-12) page 3, line 8 -page 4, line 34; claims 1,2	2-9
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A	US 5 798 632 A (MULJADI EDUARD) 25 August 1998 (1998-08-25) column 2, line 48 -column 3, line 63; figures 1,2	1-9
A	---	
A	WO 93 22819 A (SBEN SA ;ARMEL LOUIS (FR)) 11 November 1993 (1993-11-11) page 2, line 28 -page 3, line 32	1-9
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A	US 5 652 485 A (SPIEGEL R. J. ET AL) 29 July 1997 (1997-07-29) column 3, line 17-53; claim 1 -----	1-9

SA 306049

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Information on [redacted] at family members

04/12/00

International application No.

[redacted] DK 00/00558

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(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
12 April 2001 (12.04.2001)

PCT

(10) International Publication Number  
**WO 01/25628 A2**

(51) International Patent Classification<sup>7</sup>: **F03D**

(21) International Application Number: PCT/DK00/00558

(22) International Filing Date: 5 October 2000 (05.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
PA 1999 01436 7 October 1999 (07.10.1999) DK

(71) Applicant (for all designated States except US): **VESTAS WIND SYSTEM A/S** [DK/DK]; 5, Smed Sørensensvej, DK-6950 Ringkøbing (DK).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **FEDDERSEN, Lorenz** [DK/DK]; 63, Brogårdsvænget, DK-6950 Ringkøbing (DK).

(74) Agent: **CHAS. HUDE A/S**; 33, H.C. Andersens Boulevard, DK-1780 Copenhagen V (DK).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

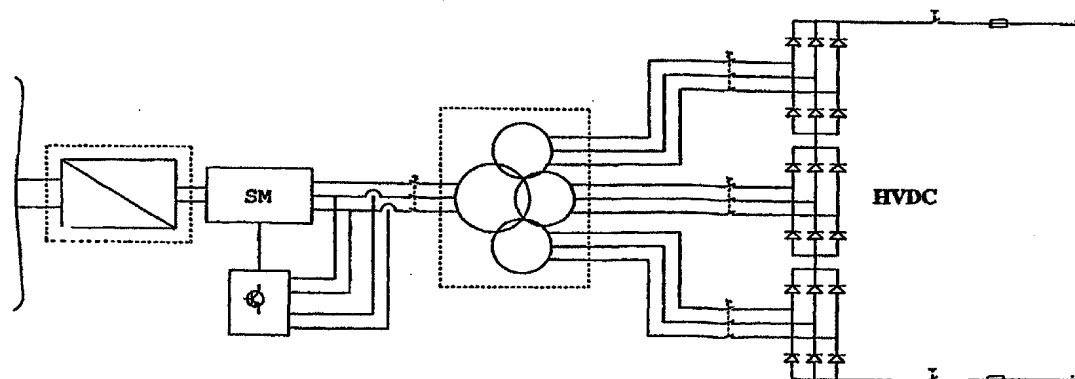
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— Without international search report and to be republished upon receipt of that report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: WIND POWER PLANT



(57) Abstract: A wind power plant where the driving shaft communicates with a synchronous generator (3) optionally through a gear (2) and with a transformer, if any, communicating through an AC/DC inverter 7 with an HVDC transmission cable 9. The synchronous generator (3) is connected to a magnetic field controller (3). In response to an output parameter, such as the power generated by the synchronous generator (3), this magnetic field controller (4) is adapted to vary the magnetic field in the generator (3) in response to said output parameter. As a result it is possible to compensate for a possible variation in the output parameter, whereby said output parameter is stabilized. As a result it is possible to compensate for a varying speed of rotation.

WO 01/25628 A2

Title: Wind power plantTechnical Field

The invention relates to a wind power plant where the driving shaft communicates with a synchronous generator optionally through a gear, and where a transformer, if any, communicates with an HVDC-transmission cable through an AC/DC-rectifier, measures being taken so as to secure against possible variations in the speed of rotation.

Background Art

The use of a DC transmission cable implies that it is not necessary to take into account the capacitive load generated by the cable. In addition, it is possible to make the HVDC transmission cables longer than the AC transmission cables. These AC transmission cables must not exceed a so-called "critical length".

WO97/45908 discloses a wind power park where each wind turbine is equipped with a synchronous generator. The output power of the synchronous generator is rectified by means of an AC/DC rectifier and carried through a DC transmission cable to a DC/AC inverter and a transformer so as to be transferred to the regional supply network. Means are provided for regulating the power. This known wind power site is encumbered with the draw-back that it cannot to a sufficient extent compensate for sudden, strong gusts, and it is not equipped with an HVDC output by means of a transformer with several output windings.

In addition, the AC/DC rectifier comprises controlled rectifiers, which are able to compensate for possible variations in the speed of rotation through a suitable control by means of particular control circuits. However, such control circuits are rather complicated.

Brief Description of the Invention.

The object of the invention is to provide a wind turbine plant where each wind turbine can tolerate sudden gusts to a far higher extent than previously known, and where each wind turbine is of a far more simple structure than hitherto known.

- 5 A wind turbine plant of the above type is according to the invention characterised in that it comprises a magnetic field controller connected to the synchronous generator, said magnetic field controller being adapted to vary the magnetic field in the synchronous generator in response to an output parameter of said synchronous generator in such a manner that possible variations in the speed of rotation are compensated for,
- 10 whereby a possible increase of the speed of rotation causes a reduction of the magnetic field in the synchronous generator. As a result, passive rectifier elements suffice in the rectifier. In addition, the controllable rectifiers and the associated control circuits are avoided which should otherwise be used for compensating for possible variations in the speed of rotation.
- 15 Moreover according to the invention the magnetic field controller may be adapted to detect the current generated by the synchronous generator, a negative feedback being established by means of the magnetic field controller for regulating the current through the rotor winding.

- In addition, the magnetic field controller may according to the invention be adapted
- 20 to detect the voltage generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.

Moreover, the magnetic field controller may according to the invention be adapted to detect the power generated by the synchronous generator, a negative feedback being established by means of said magnetic field controller.



Furthermore, the negative feedback may according to the invention include a P, I or D regulation, optionally a combination of said regulations.

Moreover, the rotor of the synchronous generator may according to the invention be dimensioned with a relatively low inductance. As a result, the time constant of the magnetic field controller can be reduced.

Moreover, the rotor may according to the invention be adapted to rotate at a relatively high speed of rotation. As a result it is possible to further reduce the inductance of said rotor.

When the generator furthermore is multipolar, it is possible to further reduce the inductance of the rotor.

#### Brief Description of the Drawings

The invention is explained in greater detail below with reference to the accompanying drawings, in which

Fig. 1 shows a wind power plant according to the invention comprising a synchronous generator and an AC/DC rectifier,

Fig. 2 illustrates a magnetic field controller for the synchronous generator of Fig. 1,

Fig. 3 shows a transformer connected to the synchronous generator,

Fig. 4 illustrates the entire plant, where the AC/DC rectifier has been shown in greater detail, and

Fig. 5 shows the voltage versus the speed of rotation at various magnetizing currents

to the synchronous generator.

### Best Mode for Carrying Out the Invention

The wind power plant shown in Fig. 1 comprises a number of arms 1 secured to a hub communicating with a synchronous generator 3, optionally through a gear 2. The synchronous generator 3 is preferably a conventional three-phase synchronous generator with an energy supply to the rotor winding not involving a collector ring. The three-phase output of the synchronous generator 3 communicates with an AC/DC rectifier 7 through a possibly three-phase transformer 5. The AC/DC rectifier 7 delivers a DC voltage to a DC transmission cable 9. The most simple embodiment of the high-voltage rectifier 7 is formed by ordinary diodes coupled in series, and accordingly it is a passive rectifier. The series coupling of the diodes is established by means of several output windings on the output of the transformer 5. In this manner the voltage is reduced to all the diodes, and the harmonic flows in the generator/transformer are reduced. The three-phase transformer 5 can be designed as indicated in Fig. 3, where the primary side is connected to the generator output and comprises a star connection, and the secondary side is connected to the AC/DC rectifier 7 and can be composed of a  $\Delta$ -connection and two combined  $\Delta$ -star connections. The voltages generated by the secondary side of the transformer 5 are transferred to an AC/DC rectifier in form of a so-called B6 diode bridge, cf. Fig. 4. This B6 diode bridge comprises a total of eighteen rectifier elements, viz. six on each secondary winding, where each of the three phase conductors of each secondary winding is connected to the connection point of two rectifier elements coupled in the same direction, said three pairs of rectifier elements being coupled in parallel. The parallel coupling of the rectifier elements associated with each of the three secondary windings is subsequently coupled in series with the result that an HVDC-voltage is transmitted from the combined coupling of rectifier elements to an HVDC transmission cable 9. This transmission cable 9 can be several km long, such as 10 km. The use of such a DC transmission cable 9 instead of an AC cable is advantageous in the

length being arbitrary and almost unlimited. Thus it is not a question of a critical length as in connection with an AC cable. The end of the DC transmission cable 9 can be connected to a conventional DC/AC inverter converting into a mains frequency and be connected to the regional supply network optionally through a three--  
5 phase transformer. Measures have, of course, been taken to ensure that the alternating voltage generated by the DC/AC inverter 7 is in phase with the regional supply network.

A demand exists, of course, for a possibility of running the wind power plant at a speed of rotation depending on the wind speed. However, an increase of the speed  
10 of rotation implies that a high voltage is generated because the voltage is proportional to the speed of rotation, cf. the curves of Fig. 5. However, the output voltage is also proportional to the magnetic field in the generator 3, which can be utilized for stabilizing the voltage in case the speed of rotation is changed. The latter has according to the invention been obtained by means of a magnetic field controller 4 detecting an  
15 output parameter of the generator 3, such as the current and the voltage or the product thereof. This magnetic field controller 4 regulates the current supply to the rotor windings in the generator in response to the output parameter. As a result, a negative feedback is established with the result that when the output power is increased the current supply to the rotor winding 3a is reduced, whereby the system automatically  
20 seeks equilibrium. When the speed of rotation for instance is increased to 130% relative to an ordinary speed of rotation, the magnetizing current to the rotor winding 3a is reduced to 80%, cf. Fig. 5. When, on the contrary, the speed of rotation decreases to 80% relative to the ordinary speed of rotation, the magnetizing current to the rotor winding 3a is increased to 130%.

25 Fig. 2 shows an embodiment in greater detail of the magnetic field controller 4, and it appears that in two of the three phases of the generator the currents IG1, IG2 and the voltages UG1, UG2, respectively, are detected. These parameter values are multiplied in pairs to obtain an expression of the output power  $P_{gen}$ . This output

power  $P_{\text{gen}}$  is compared with a reference value  $P_{\text{ref}}$ , and the difference therebetween, viz. the error signal, is transferred to a regulation unit 11. In response to this error signal, the regulation unit generates a value for the magnetizing current  $I_m$  which is to be transferred to the rotor winding, optionally through a PWM 12 (Pulse Width Modulator) and an amplifying power transistor 13 controlling the supply of current to the rotor winding. The negative feedback is established by the detected power  $P_{\text{gen}}$  being deducted from the reference power  $P_{\text{ref}}$ . As a result a detected increased power  $P_{\text{gen}}$  implies that the error signal is reduced and that the power supplied to the rotor windings is reduced as well.

- 10 The power for the magnetizing of the generator 3 is typically of the magnitude 1 % of the nominal power of the generator.

A portion of the magnetizing can optionally be provided by means of permanent magnets, where an electric magnetizing is then used for controlling the speed of rotation. The speed of rotation is downwardly limited by a maximum magnetizing current due to the limited thermal properties of the rotor windings and the magnetic structure of the generator, viz. the magnetic saturation. In order to extend the lower limit of the speed of rotation it is therefore advantageous when either the generator is provided with an additional output presenting an increased nominal output voltage or the transformer is provided with an input presenting a reduced nominal voltage.

20 These additional inputs are only to be dimensioned for low power as the wind energy is low at a low speed of rotation.

According to a particularly advantageous embodiment, the wind turbine comprises a transformer with  $n$  output windings coupled in series with rectifiers so as to obtain an HVDC. The output windings can be coupled as a star or a  $\Delta$  or as a combination thereof in order to obtain a sinusoidal input current.

25

Claims

1. A wind power plant where the driving shaft communicates with a synchronous generator (3) optionally through a gear (2) and with a transformer, if any, with n output windings, said transformer communicating through an AC/DC rectifier with  
5 an HVDC transmission cable (9), measures being taken so as to secure against possible variations in the speed of rotation, c h a r a c t e r i s e d by a magnetic field controller (4) connected to the generator (3), said magnetic field controller (4) being adapted to vary the magnetic field in the synchronous generator (3) in response to a speed of rotation-depending output parameter of said generator (3) in such a manner  
10 that possible variations in the speed of rotation are compensated for.
2. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the currents (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
- 15 3. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the magnetic field controller (4) is adapted to detect the voltages (IG1, IG2) generated by the synchronous generator (3), a negative feedback being established for regulating the current through the rotor winding (3a).
4. A wind power plant as claimed in claim 1, c h a r a c t e r i s e d in that the  
20 magnetic field controller (4) is adapted to detect the power generated by the generator (3), a negative feedback being established for regulating the current through the rotor winding (3a) in response to the detected power.
5. A wind power plant as claimed in claim 4, c h a r a c t e r i s e d in that the negative feedback for regulating the current through the rotor windings (3a) includes  
25 a P, I or D regulation or a combination thereof.

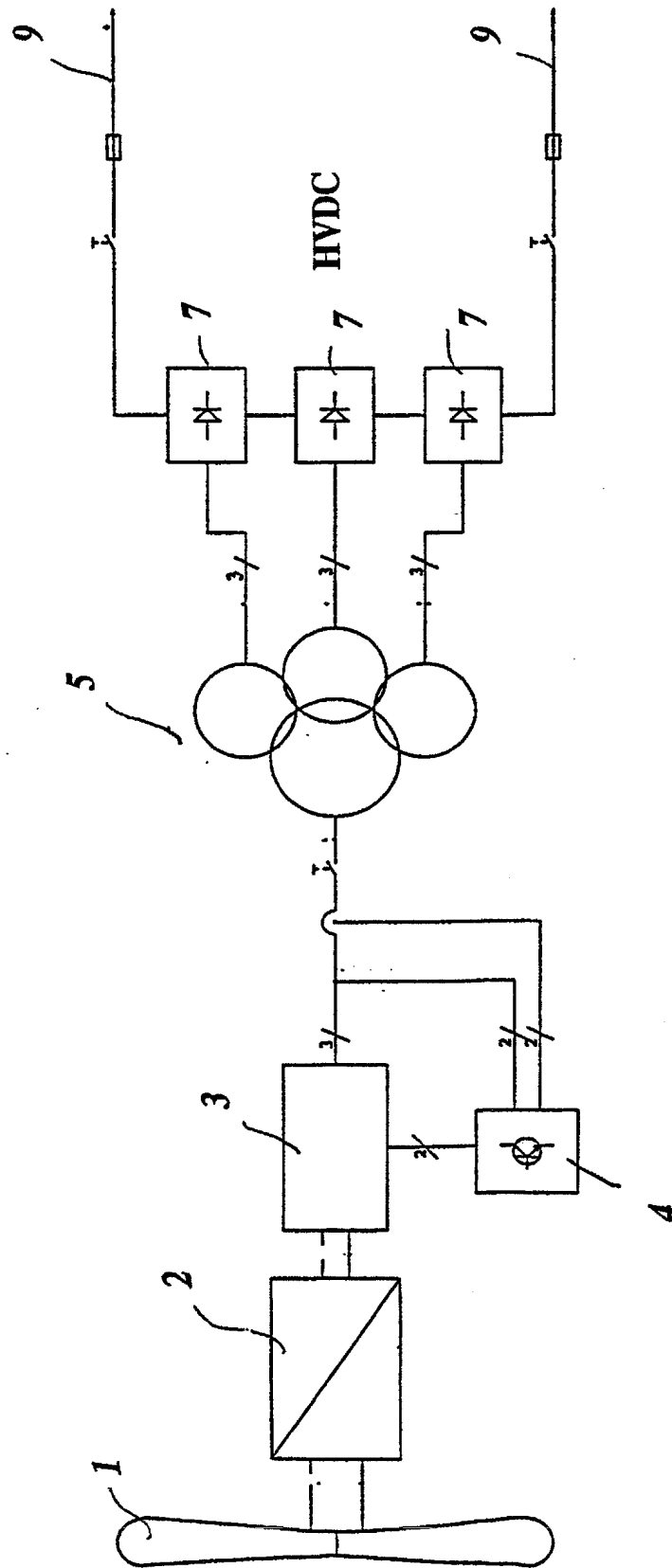
6. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the rotor windings are dimensioned with a relatively low  
inductance.

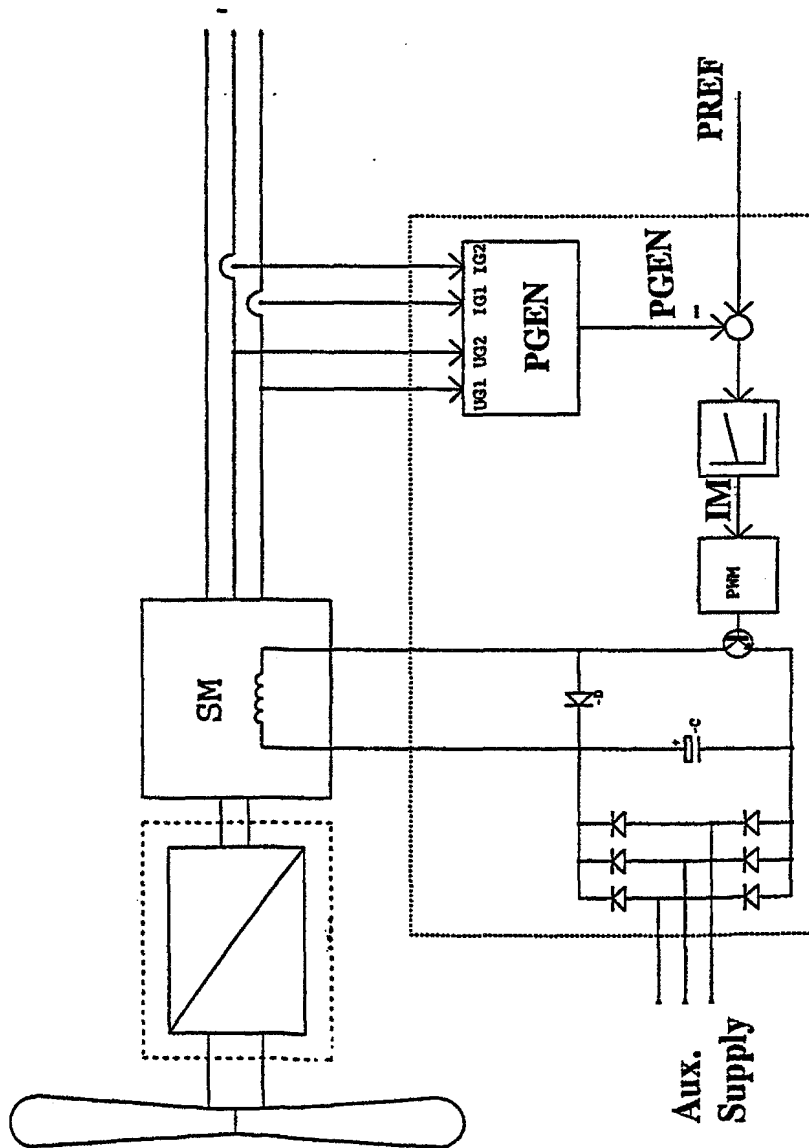
7. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
5 a c t e r i s e d in that the rotor is adapted to rotate at a relatively high speed of  
rotation, whereby the inductance can be further reduced.

8. A wind power plant as claimed in one or more of the preceding claims, c h a r -  
a c t e r i s e d in that the synchronous generator (3) is multipolar.

9. A wind power plant as claimed in one or more of the preceding claims, where the  
10 wind turbine comprises a transformer with n output windings coupled in series with  
n rectifiers so as to obtain an HVDC.

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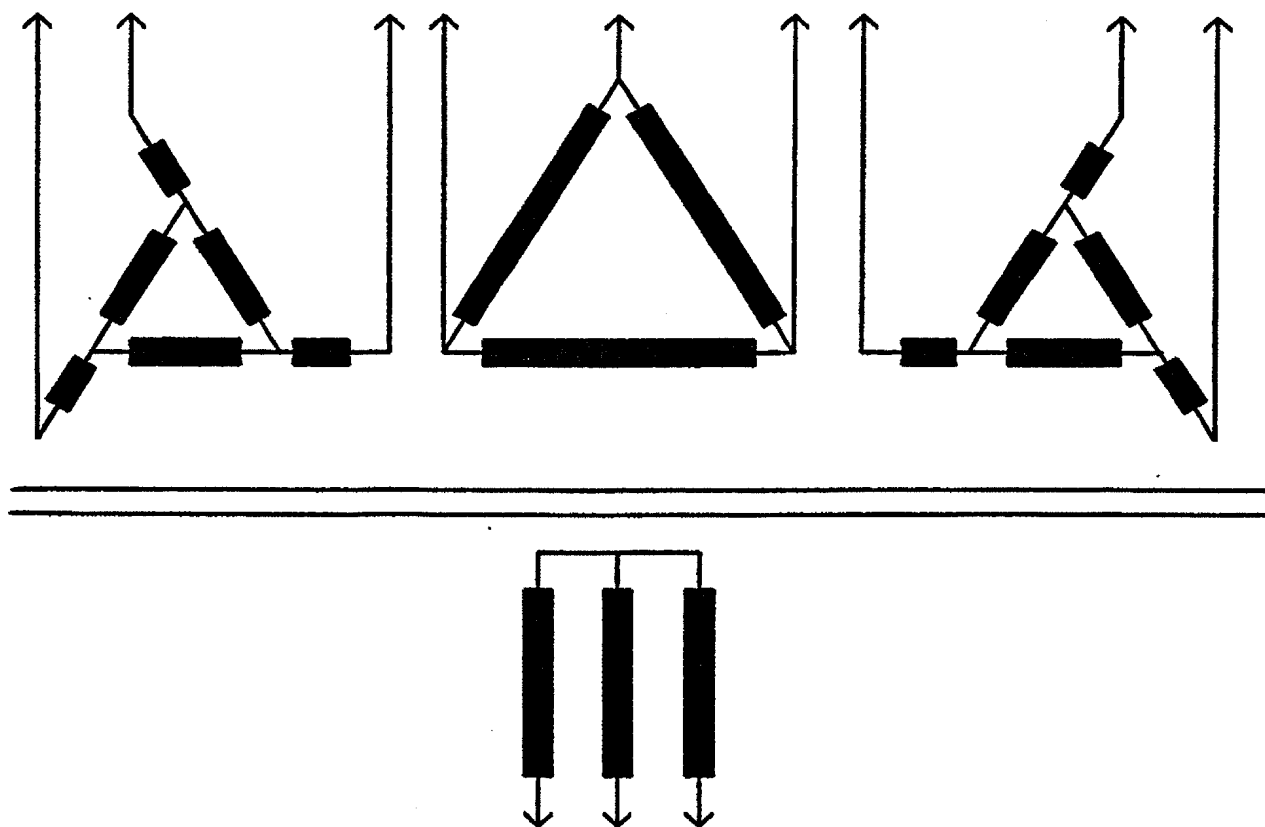
**Fig 1**



**Fig 2**



Fig 3



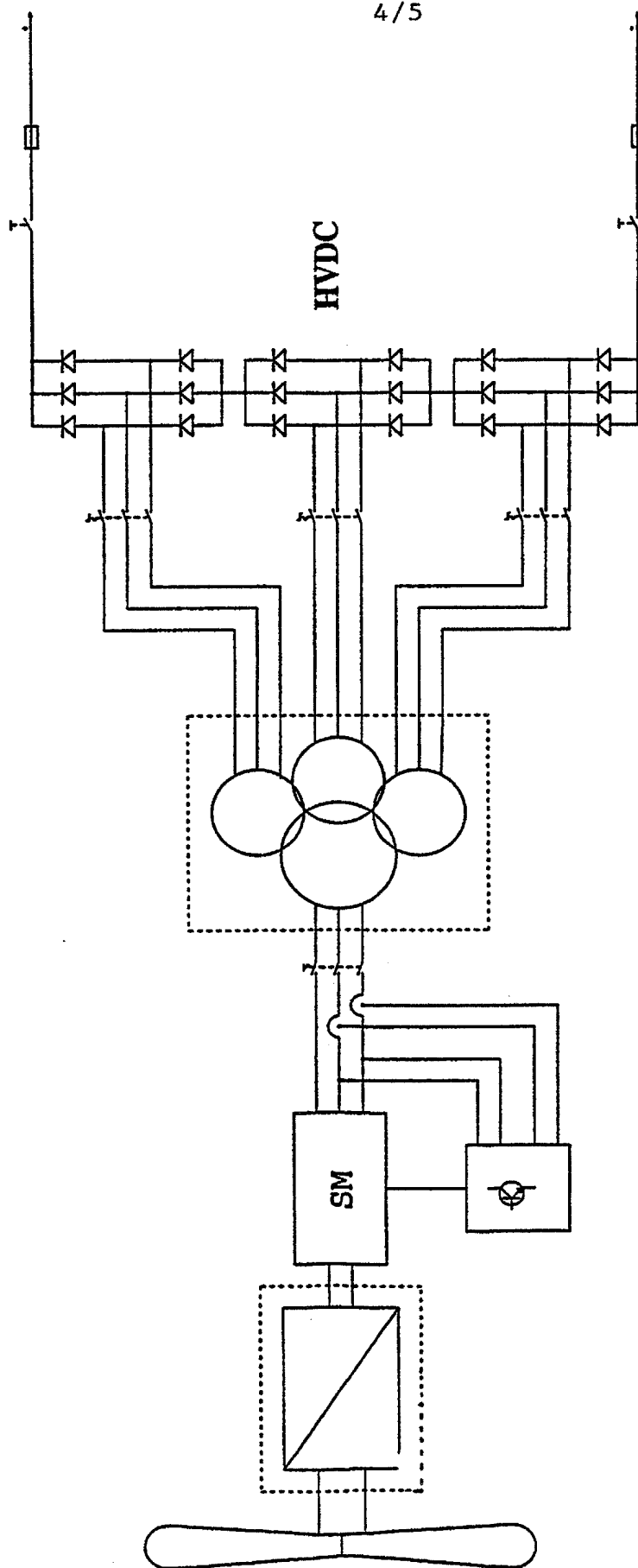


Fig 4

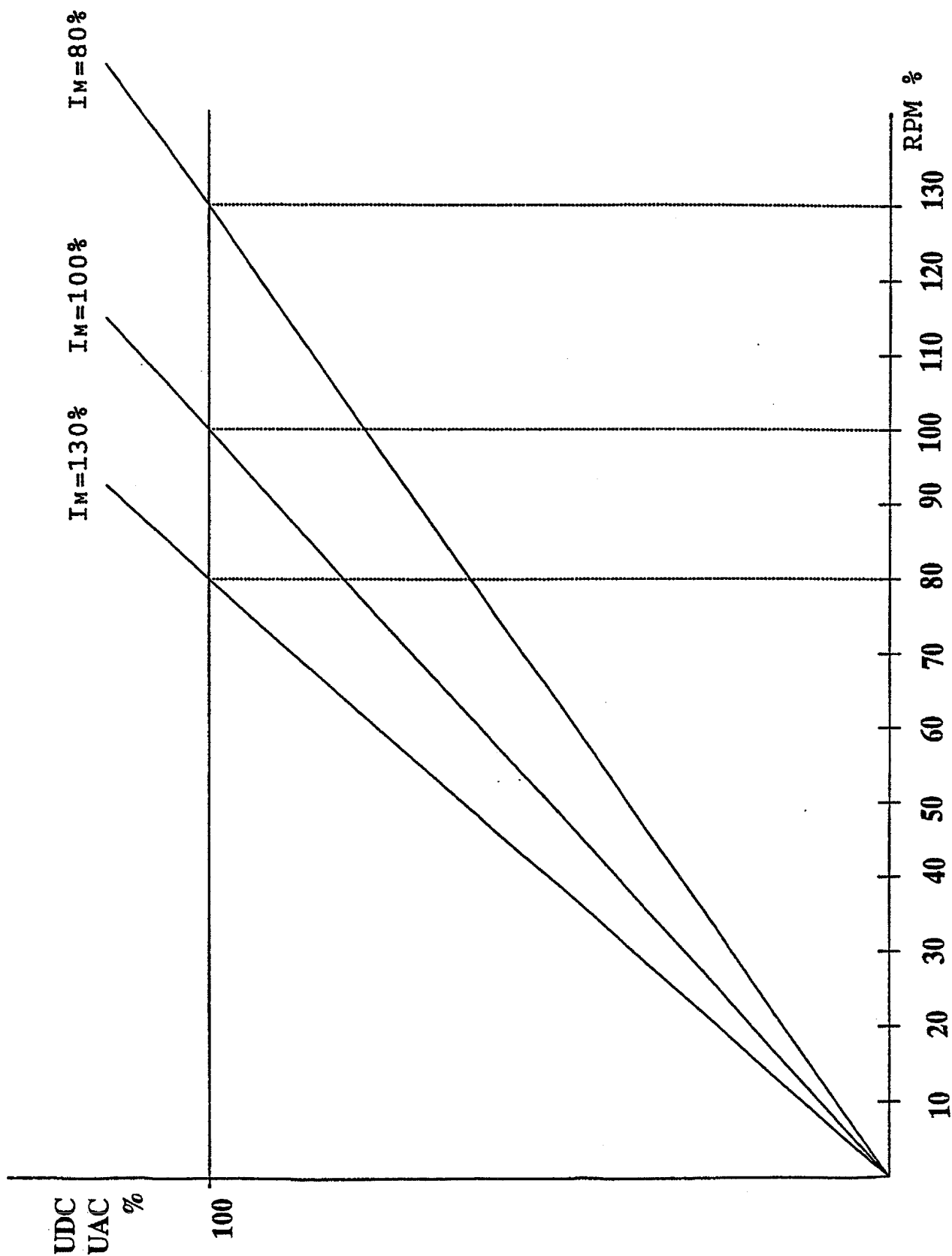


Fig 5

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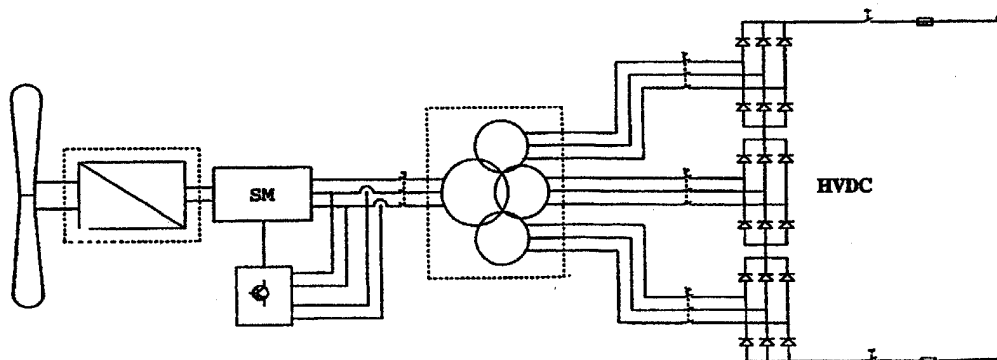
(43) International Publication Date  
12 April 2001 (12.04.2001)

PCT

(10) International Publication Number  
WO 01/25628 A3

- (51) International Patent Classification<sup>7</sup>: F03D 7/00, H02P 9/00 // F03D 11/00
- (21) International Application Number: PCT/DK00/00558
- (22) International Filing Date: 5 October 2000 (05.10.2000)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
PA 1999 01436 7 October 1999 (07.10.1999) DK
- (71) Applicant (for all designated States except US): VESTAS WIND SYSTEM A/S [DK/DK]; 5, Smed Sørensensvej, DK-6950 Ringkøbing (DK).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): FEDDERSEN, Lorenz [DK/DK]; 63, Brogårdsvenget, DK-6950 Ringkøbing (DK).
- (74) Agent: CHAS. HUDE A/S; 33, H.C. Andersens Boulevard, DK-1780 Copenhagen V (DK).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:  
— with international search report
- (88) Date of publication of the international search report:  
11 October 2001
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: WIND POWER PLANT



(57) Abstract: A wind power plant where the driving shaft communicates with a synchronous generator (3) optionally through a gear (2) and with a transformer, if any, communicating through an AC/DC inverter 7 with an HVDC transmission cable 9. The synchronous generator (3) is connected to a magnetic field controller (3). In response to an output parameter, such as the power generated by the synchronous generator (3), this magnetic field controller (4) is adapted to vary the magnetic field in the generator (3) in response to said output parameter. As a result it is possible to compensate for a possible variation in the output parameter, whereby said output parameter is stabilized. As a result it is possible to compensate for a varying speed of rotation.

WO 01/25628 A3

# INTERNATIONAL SEARCH REPORT

Internat PCT/I	Application No J/00558
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**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 F03D7/00 H02P9/00 //F03D11/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
 IPC 7 F03D H02P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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X	WO 92 14298 A (US WINDPOWER) 20 August 1992 (1992-08-20) page 3, line 1 -page 8, line 4 page 14, line 18 -page 15, line 24; figures 1-3,13	1,8,9
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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Date of the actual completion of the international search

22 December 2000

Date of mailing of the international search report

20. 04. 2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
 Fax: (+31-70) 340-3016

Authorized officer

Peter Göransson

# INTERNATIONAL SEARCH REPORT

Internatio Application No  
PCT 00/00558

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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SA 26049

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Information on patent family members

04/12/00

International application No.

PCT/DK 00/00558

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